Participatory Action Research as an Approach to Performing Research in Engineering Education with Native American Communities

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Abstract

This paper discusses the rising interest in encouraging more K-12 Native American students to pursue careers in the engineering field. This trend presents two opportunities. First, it helps Native American students to become aware of a field that they may not have considered pursuing a career in otherwise. Second, Native Americans have a unique and valuable perspective of the world. If Native Americans continue to be underrepresented in the engineering field, it compromises the diversity of solutions that are required for solving the toughest engineering problems that the world currently faces. Despite the benefits in conducting research into how to increase the number of Native American engineers, any research in this area must be conducted carefully. It is important that engineering education researchers who wish to work with Native communities are aware of the past injustices that several communities have suffered by research institutions. Participatory action research is presented as an appropriate approach to conducting research with these groups. A brief summary of participatory action research will be presented. Next, there will be a discussion on some of the benefits of using participatory action research with Native communities in the area of engineering education. The paper will then conclude with the five key components that need to be present in order to ensure that a participatory action research project in these communities is successful; communication, mutual respect, balance, flexibility, and a willingness to learn and grow.

Keywords

Participatory Action Research, Native American Communities, Engineering Education

Introduction

According to the 2010 census, 0.9% of the total population in the United States is made up of American Indians or Alaska Natives[1]. Yet, only 0.5% of the country's total number of engineering bachelor's degrees were awarded to Native students during 2002 to 2010[2]. The discrepancy is even more apparent in the labor force where only 0.3% of the total number of scientists and engineers that are performing traditional science and engineering occupations are Native American[3].

Recently, there has been an increasing amount of interest from the U.S. federal government in supporting Native education. As a result, the federal government has started initiatives such as Generation Indigenous[4] as well as a collaboration between the Department of the Interior and the National Park Service to keep Native students interested in science, technology, engineering, and math (STEM)[5]. By providing Native American K-12 students more opportunities to learn about engineering, it provides them the opportunity to consider pursuing a career that they may not

have otherwise considered. A career in engineering will provide Native Americans with skills that they can use to improve conditions in their own communities. In addition to the potential positive impact engineering education may have on Native communities, it also provides benefits to the engineering field at large. Native Americans have a unique and valuable perspective. If they are not well-represented in the engineering field, it compromises the diversity of solutions that are required for solving the toughest engineering problems that the world currently faces[6].

The need for a greater representation of Native Americans in the engineering field along with these new funding opportunities are bound to create interest among engineering education researchers. However, because of the history of exploitation and harm that has come to Native communities through research institutions, a researcher must take special care in working with these communities. For those researchers who are looking to perform research with Native Americans in the area of engineering education, the authors recommend using a participatory action research (PAR) approach.

In this paper, a brief summary of PAR will be described. The benefits of a PAR approach compared to a more traditional research project will be discussed. Finally, the paper will outline the five key components that are required for a successful PAR project in a Native community, and end in a brief conclusion.

Motivation for Participatory Action Research with Native Communities

Native Americans are one of the most highly studied ethnic groups in the United States. There have been a number of cases where a performed research study has directly harmed a Native community. One of the more infamous cases occurred in the 1990s when Arizona State University conducted a research project with the Havasupai. The project involved drawing blood samples from the members of the tribe to see if their DNA was predisposed towards Type-II Diabetes, a disease that heavily afflicted the tribe. The blood samples were then distributed around the country and used for other research topics such as inbreeding and studies on migration patterns from Asia to North America without tribe's or donors' consent[7]. Not only did neither of these studies benefit the Havasupai community, they caused direct harm to its people. Conducting a study on inbreeding stigmatized the Havasupai people while the migration study directly undermined the religious beliefs regarding their origin[8].

What is Participatory Action Research?

PAR is a member of the classification of research known as action research. The genesis of action research is most often attributed to German-American social psychologist, Kurt Lewin, in his journal article, "Action Research and Minority Problems[9]." Rapoport describes action research as aiming to "contribute *both* to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework[10]." There are three reoccurring themes that appear when action research is defined; participation, action, and research[11].

Kurt Lewin strongly pushed for participation and democracy in action research[12]. Participation of the community is an important element of action research for a number of reasons. First, the community has an intimate knowledge of the issues that they face[13]. Second, the community can

help guide the action portion of the project to interventions that are likely to receive a positive response from the community[14]. Third, the community researchers will remain in the community long after the research study. By involving them in a meaningful way, it gives them ownership of the project and helps to generate long-lasting change in the community.

Action research is neither a pure research project, nor is it solely an outreach project. In order for a study to be considered action research, it needs to both generate social theory and social change. An action research study generates social theory that helps explain and resolve the issues that the community faces[13] through a "systematic inquiry that is collective, collaborative, self-reflective, critical, and undertaken by the participants of the inquiry[15]." The social theory that is generated is then used to guide action that transforms the community's environment[16]. As a result, action research is in a unique position to help bridge the gap between social theory and social practice[17].

Although action research is not inherently qualitative in nature, qualitative methods are commonly associated with it[18]. Another characteristic of action research is its iterative nature[13,16]. Lewin himself described action research as, "…a spiral of steps each of which is composed of a circle of planning, action, and fact-finding about the result of the action[19]." In the first step, the community meets to examine the issue it faces and develop a plan for overcoming it. Next, the plan is implemented. Finally, during the fact-finding phase, the community evaluates the effectiveness of the action as well as learns how to improve it. This information is then utilized to modify the next step of the process as well as the plan for the project as a whole. The cycle begins again with the next iteration of the planning phase, however, this time with feedback from the previous iteration.

Action research can be broken down into three categories depending on which theoretical perspective it is approached from; technical action research (TAR), mutual-collaborative action research (MCAR), and PAR[13, 18, 20]. The first category, TAR, utilizes a positivist perspective[13]. In TAR, the external researcher is responsible for both identifying the problem and determining the most appropriate form of intervention[9]. The second, MCAR, takes an interpretivist approach[13]. Through dialogue, the external and community researchers work together to identify the problem and appropriate intervention. The final category, PAR, often associated with Brazilian educator and philosopher Paulo Freire[21,22], is based on critical theory[23]. In addition to generating social change and social theory, there is an additional emphasis on empowering the community to help develop these changes. This is done by directly involving the community in every phase of the research project, from the research design to the dissemination of results[24], as co-researchers rather than as research subjects[25]. This helps the community become aware of their resources and develops their ability to solve problems on their own[26].

One major area where the three categories of action research distinguish themselves from the others is how power is allocated. In all forms of action research, participation is a key element. However, participation does not necessarily imply equal power sharing. In TAR, power rests within the guiding "idea" of the project. The external researchers tend to have sole ownership of the idea, thus giving them control over the project. In MCAR, every individual in the project has an equal share of the power. Finally, in PAR, power rests solely within the group as a whole, not within the individuals of the group[13]. See Fig. 1 for a summary of how power is allocated in each of the three branches of action research.

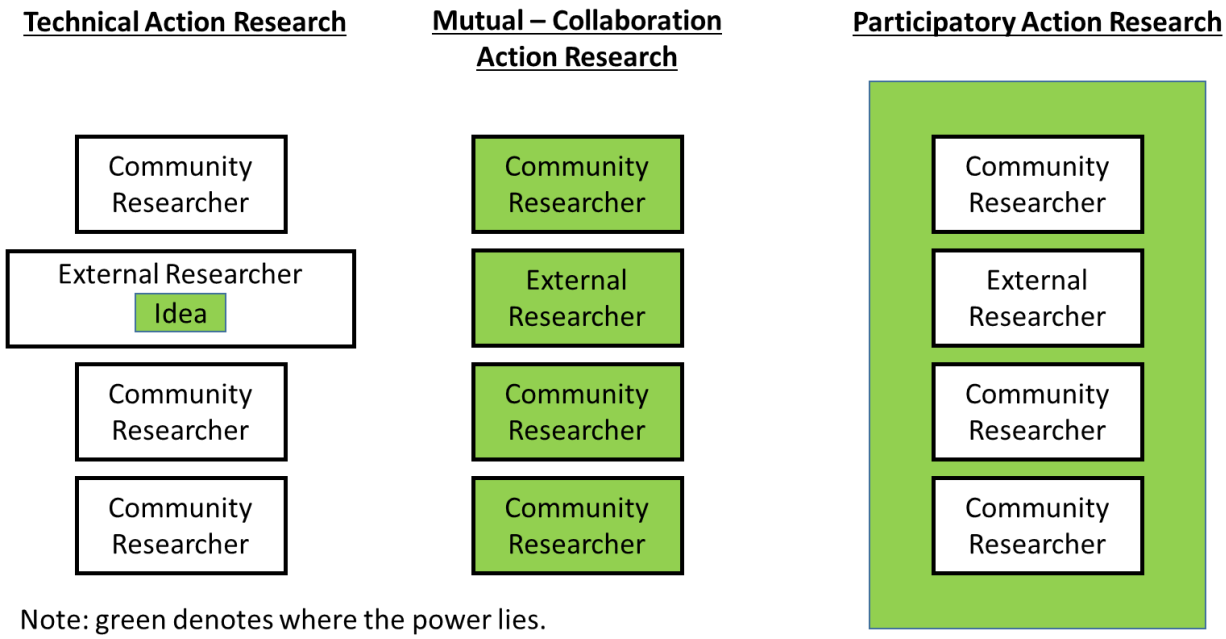

Figure 1. Allocation of power in the different categories of action research

In some PAR studies, the authors refer to the researchers from outside the community as simply "researchers." These same studies refer to the community researchers as "participants." It is the opinion of the authors of this paper that these are misnomers because they imply that the "researcher" has more authority in the project than the "participants[27,28]." In a true PAR project, there must be a balance between these two groups. In actuality, all members of the project are simultaneously participants and researchers. To reinforce the equality of all members in a PAR project, this paper will refer to members of the project that come from institutions outside of the community as "external researchers." Similarly, the members of the project that come from within the Native community will be referred to as "community researchers."

Benefits of PAR

PAR offers a number of benefits when working with Native communities compared to more traditional research. First, by allowing power to rest within the group and not in any particular individual, it helps to prevent damage and exploitation caused to the communities by external research institutions[29]. Second, it has the potential to rebuild the trust between Native and research communities. Third, once trust has been established, it may be possible for the external researcher to gain access to perspectives and knowledge that might not be obtainable without using a PAR approach[23].

PAR offers another benefit for engineering education researchers. The iterative nature of the action research cycle has many similarities with the engineering design process. Table 1 shows a comparison between the action research cycle and the engineering design process. Just as there is no consensus in the individual steps of the engineering design process, there is also no agreement in the steps for action research. As a result, two examples from both processes are presented for comparison. For action research, both Kurt Lewin's and Gerald Susman's interpretations of the

action research cycle are presented. While the Accreditation Board for Engineering and Technology (ABET) does not have an official list of steps required for the engineering design process, it is defined formally as "…the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic science and mathematics and engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing, and evaluation[30]." From this description, the authors of this paper were able to derive a series of steps that describe the engineering process from ABET's interpretation. The engineering design process used in NASA's Beginning Engineering, Science, and Technology (BEST) program was chosen as the second representative for the design process due to its engineering education perspective[31]. The focus of this comparison is not to convince the reader that these methods are equivalent, but a familiarity with the engineering design process may aid engineering education researchers in the adoption of the PAR approach as well as help them justify its usage in the engineering education field.

Table 1. Key Comparison of Action Research and the Engineering Design Process

Kurt Lewin's Model of Action Research[19]	Gerald Susman's Model of Action Research[32]	ABET (2015) Derived Engineering Design Process	NASA's BEST Engineering Design Process[31]
	Diagnosing – identifying or defining a problem	Identification of Need	Ask – ask questions
		Definition of Problem	Imagine – imagine possible solutions
Planning – examine ideas carefully in light of the means available	Action Planning – considering alternative courses of action for solving a problem	Synthesis	Plan – plan out a design
Acting – implement the plan	Action Taking – selecting a course of action	Analysis	Create – create and construct a working model
		Construction and Testing	Experiment – experiment and test the model
Fact Finding – evaluate the action, learn from it, modify the plan to improve it	Evaluating – studying the consequences of an action	Evaluation	Improve – revise and try to improve the model
	Specifying Learning – identifying general findings		

Key Components to a Successful PAR Project in a Native Community

Based on an initial examination of the literature for emergent themes using thematic analysis, the authors have identified five key components that are critical to ensure the success of any PAR project. Special attention paid to these five components can alleviate some of the issues that

might arise when working with a Native community. It is important that everyone involved in the project, outside researchers and community researchers alike, understand the importance of these components.

a) Communication

Communication plays an important role in any project. However, due to the fact that many Native Americans pass down their history, stories, and rituals orally, the spoken word and thought are especially significant in these communities[33]. There are two main areas of communication to be concerned with, communication between the external and community researchers and communication between the PAR group and the outside world. In the first case, it is important to keep in mind that the members of certain Native communities may not speak English as a first language, or in some cases, may not speak English at all. In 2011, 27% of American Indians or Alaska Natives alone ages five and older did not speak English at home. This number may jump dramatically, such as the case with one tribe where 68% of their people speak a language other than English at home[34]. This language barrier unfortunately can create opportunities for misunderstanding. Additionally, some of the concepts derived from a tribe's culture may not adequately translate into English. To help mitigate some of these issues, it is important to include Native speakers in the research project[33].

It is also important that external and community researchers discuss issues such as roles, expectations, and ownership of the research upfront in order to avoid situations like the Havasupai exploitation[25,29]. Coming to a mutual understanding of what the external and community researchers expect to get out of the performed research can help reduce the risk of potential conflict later in the study.

It is not uncommon in a PAR study for the external researcher to take the lead on publishing the results. This is natural since the external researcher typically has more to gain from publishing than the community may. However, it is extremely important that the community is still involved in the writing process. In the best case, some of the community members are co-authors on any publications released by the group[25,29]. At the very least, the community should review whatever is written and approve it before it is published. This will help prevent issues of presenting the community in a negative light or the incorrect portrayal of their people and culture[29].

In one study, external researchers were working with Alaskan Native community researchers to address the issue of alcohol abuse. During the investigation, it became clear that the community wanted to redefine the study to focus on sobriety. Rather than focus on what factors contributed to motivating a Native Alaskan to drink, they instead began investigating what were the factors that allowed them to remain sober[14]. This redefinition of the study promoted the strengths of the community and their culture and ensured that the interests of the community were not compromised when the results of the study were released to the outside world.

In some cases, researchers may need to get approval from a tribal review board to publish any of the results of the project. This board's job is to protect the tribe from any harmful effects that research projects may create, such as the case of the Havasupai[29]. Going through this process helps empower the community by giving them control over how they wish to present their research as well as their people to the outside world. This also helps to validate the research since

the problem statement, methods, and evaluation of the project must all be approved by the community.

b) Mutual Respect

As mentioned earlier, some researchers have broken the trust between Native communities and external research groups. External researchers who show proper respect to these communities may be able rebuild some of that lost trust. Respect is shown when external researchers are sensitive to cultural differences, genuinely acknowledge that the community has valuable knowledge and skills to contribute towards the project, and by putting the needs and well-being of the community first.

A conflict may arise if the study reveals something that is unflattering about the community. The external researcher may feel obligated to publish the project's findings, but risks harming the community. As mentioned before, the needs and well-being of the community must remain the main priority of the external researcher. In some cases, these unflattering results may be omitted without compromising the integrity of the project as a whole[25].

Mutual respect also requires that the community respects the unique perspective that the external researchers can offer. This level of mutual respect takes time and dedication to reach. However, if respect is not eventually shared among all participants in the project, there is little hope that the project will be successful.

c) Balance

As mentioned earlier, the success of a PAR study hinges on the fact that there is a balance in power between the external and community researchers. One sign that there may be an imbalance in the group is a lack of conflict. This may imply that members with conflicting views feel intimidated or afraid to express their opinions[23]. This loss of viewpoint compromises the entire PAR approach to research. As a result, it is very important that the facilitator of any group meetings works hard to create an atmosphere where everyone is comfortable voicing their thoughts.

There also needs to be balance in the distribution of responsibilities for the project. If only a few members are contributing to the project, this may be a sign that the community is not interested in the project, the project was not advertised or explained well, or perhaps the community members do not have the time or resources to contribute. While it may be tempting for the external researcher to take on extra responsibilities in order to "save" the project, this inherently creates a power imbalance which can sabotage the participatory nature of the project[23]. Instead, the external researcher needs to engage the community to reevaluate their current situation to understand why other individuals are unable to participate and to ultimately determine the required steps to get the project back on track.

Finally, in some cases it is possible that the external researchers become so focused with trying to see the world from the community's perspective, that they forget their own[23]. Again, this loss of perspective undermines the project. This can be prevented by simply being aware that this phenomenon might occur and to engage in periodic self-reflection.

d) Flexibility

Due to the unpredictable nature of a PAR project, it may require significant flexibility from the external researcher. Having to relinquish some of the power in the study that they are typically used to having may cause researchers to feel uncomfortable[27]. They may not be able to use the research methods that they are accustomed to using if the community feels that they are not appropriate[35]. For example, in one study, a research group asked for volunteers to interview from an Alaska Native community. The researchers only needed 36 volunteers, but over 150 had volunteered to tell their story. The researchers had limited time and funding, so they were only going to interview 36 people until the community shared the cultural implications of this decision. The community members had made a commitment to share their story with the researchers. Turning away the additional volunteers would have been insulting and against the values of their culture. As a compromise, the researchers performed longer more in-depth interviews for 36 of the community members and then shorter ones for the rest of the volunteers[14].

The additional process of having to get approval from a tribal review board can complicate the publication process. Researchers will need to be flexible with the content of their writing. They also need to include this additional process in their timeline to ensure that all of the publication deadlines are met[14].

e) Willingness to Learn and Grow

One of the unique and powerful aspects of PAR is that it has the ability to both transform the community as a whole, as well as the individual members of the research group[25]. A PAR project acknowledges that both the external and community researchers have valuable skills and knowledge to contribute towards the project. For example, the community researcher's unique perspective may be helpful when choosing which methods are appropriate for the study. Not only does this empower the community[35], but it may actually help collect more accurate data. For example, in one study with the Yup'ik, external researchers suggested the use of narrative projective techniques. The community researchers told them that many of the older community members would find this insulting since "telling stories about pictures was for children[14]." This insight from the community helped the external researchers avoid using a data collection method that was inappropriate to the community.

In order to maintain the balance in the project, external researchers should also be careful that they do not discredit their own insight and knowledge. Learning should be a reciprocal process for both the community researchers and the external researchers[28]. In the same study with the Yup'ik, the group eventually decided that the Likert scale was an appropriate method. However, the community researchers suggested using a tool similar to a slide rule to allow the community to provide their answer by sliding a bar along a continuum, rather than providing a discrete answer[14]. In this way, both the external and community researchers may have learned a new method, or at least variation of a method, to help in their future research. It is important that external researchers not only acknowledge the value that the community researchers' knowledge can contribute to the project, but also acknowledge the transformative effects that this same knowledge can have on themselves if they simply remain open to it.

The five components and how they contribute towards the success of a PAR project in a Native community are summarized in Table 2.

Table 2. Key Components and Their Contribution towards a PAR Project

Key Component	How Component Contributes towards the Research
Communication	• Helps overcome language barriers • Creates understanding regarding roles and expectations of project members and ownership of research • Tribal review board process can protect the interests of the community as well as empower the community to portray themselves to the outside world under their own terms • Tribal review board process can also help validate results of the research
Mutual Respect	• Rebuilds lost trust between Native communities and external research institutions • Protects the community's interests
Balance	• Ensures that viewpoints from all the stakeholders in the project are represented
Flexibility	• Allows the community to decide which methods are culturally appropriate • Ensures enough time to meet publication deadlines
Willingness to Learn and Grow	• Positively transforms the community as well as the individual external and community researchers

Future Work

The methodology of PAR has been presented as alternative to traditional research approaches when dealing with Native American communities. One specific implementation of how PAR can improve the engineering education field is through the development of culturally-contextualized engineering curriculum. Native Americans have different ways of knowing that do not always align with traditional Western thinking. In order to broaden participation in the engineering field, Native students need to be encouraged to pursue engineering through curriculum and outreach programs that are culturally relevant to them. This will allow students to not see engineering as contradictory to their own way of life. Their differing worldview is exactly what the engineering field needs in order to increase the diversity of solutions that are necessary for solving the world's most difficult problems. Native students need to embrace their culture as a strength in engineering, not a hindrance. This can only be accomplished by working with the community as equal partners. This will be the topic for further research by the authors.

Conclusion

In conclusion, there is a need for more Native Americans to become engineers. Engineering education researchers who are interested in working with these communities in order to increase interest in engineering should be aware of the history of exploitation and harm that research has

created for some of these communities. One way interested engineering education researchers are able to prevent these injustices from occurring in the future is to take a PAR approach to their research. While a PAR project is very difficult to implement, a successful project is obtainable if all five of the key components of communication, mutual respect, balance, flexibility, and a willingness to learn and grow are present. If performed properly, a PAR project has the potential to not only be a powerful positive and transformative force in the community, but also on the external researcher as well.

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